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THE CLASSIFICATION OF EDUCATIONAL OBJECTIVES, PSYCHOMOTOR DOMAIN.

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A SCHEMA FOR CLASSIFYING EDUCATIONAL OBJECTIVES IN THE PSYCHOMOTOR DOMAIN WAS DEVELOPED. THE GENERAL PROCEDURES INCLUDED (1) A COMPREHENSIVE REVIEW OF RELATED LITERATURE, (2) THE COLLECTION AND ANALYSIS OF BEHAVIORAL OBJECTIVES OF THE DOMAIN, (3) LABORATORY ANALYSES OF CERTAIN TASKS TO DISCOVER BY OBSERVATION AND INTROSPECTION THE NATURE OF THE PSYCHOMOTOR ACTIVITY INVOLVED, AND (4) CONFERENCES WITH SCHOLARS WHO HAD SPECIALIZED KNOWLEDGE OF THE DOMAIN. THE TENTATIVE CLASSIFICATION SYSTEM WAS PRESENTED IN TAXONOMIC FORM IN THE CONCLUSION OF THE REPORT. (GC)

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ABSTRACT

Contract No. OE 5-85-104

The Classification of Educational Objectives, Psychomotor Domain

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July 1, 1965 - May 31, 1966

Purpose: To develop a classification system for educational objectives, psychomotor domain, and if possible, in taxonomic form.

Work on development of a classification system for educational objectives in the psychomotor domain has been exploratory in nature. General procedures included: (1) a comprehensive review of related literature, (2) the collection and analysis of behavioral objectives of this domain as one way of gaining insight regarding a possible classification system, (3) laboratory analyses of certain tasks to discover by observation and introspection the nature of the psychomotor activity involved, and (4) conferences with scholars who have specialized knowledge of the nature of psychomotor activity, development of classification systems for educational objectives, and of the areas of study where educational objectives in the psychomotor domain are of paramount concern.

A schema for classifying educational objectives in this domain has been developed. It follows in its present form, which is to be considered tentative, flexible, and incomplete.

1.0 Perception

- 1.1 Sensory stimulation
  - 1.11 Auditory
  - 1.12 Visual

1.13 Tactile
1.14 Taste
1.15 Smell
1.16 Kinesthetic

1.2 Cue selection

1.3 Translation

2.0 Set

2.1 Mental set

2.2 Physical set

2.3 Emotional set

3.0 Guided response

3.1 Imitation

3.2 Trial and error

4.0 Mechanism

5.0 Complex overt response

5.1 Resolution of uncertainty

5.2 Automatic performance

The investigator believes that the schema in its present form will be useful. Whether there is sufficient distinction between one category and another is still a question. Perhaps additional subcategories to improve the discrimination quality are needed for some of the major sections.

Another question needing investigation is: Is there perhaps a sixth major category which might be designated as adapting and originating? At this level, the individual might be so skilled that he can adapt the action in terms of the specific requirements of the individual performer and the situation. He might originate new patterns of action in solving a specific problem.

Much work is needed in terms of the relationships among the three domains: the cognitive, affective, and psychomotor. In particular, explorations of the behavioral aspects of broad objectives in an "action-pattern" domain, beyond and encompassing the other three, are needed.

FOREWORD

Work on the development of classification systems for educational objectives in the cognitive and affective domains has been impressive. The publications resulting from this work have had wide circulation and use. It was the hope of the chief investigator on the present project that eventually a classification system for the pyschomotor domain might be achieved which would be as useful in the analysis of related educational objectives as the other two systems have been for their respective domains.

Interest in this project developed through discussions with Professors Alfred Krebs and Jacob Stern, who were named associate investigators on the project. A number of discussions centered about the kinds of objectives that might be characterized as dealing with the psychomotor and "what happens" when you carry out a motor act.

The first formal work on the project was supported by a small grant by the Bureau of Educational Research, College of Education, University of Illinois. A half-time research assistant worked with the investigators in the initial phases which are given in the report.

The grant from the U.S. Department of Health, Education, and Welfare, Office of Education, made possible further exploration and the eventual achievement of a classification system which is still to be considered tentative, flexible, and incomplete. It provided for two research assistants who devoted many hours to a review of relevant literature, to the analysis of educational objectives concerned with abilities and skills, and to the analysis of motor acts, especially selected ones related to the content of their own field, which is home economics education.

What follows is to be considered a progress report. How does one know when he has reached a reasonable terminal point with a project of

this sort? Certainly such a point has not been achieved as yet. On the positive side, the investigator believes that considerable progress has been made, that the work that has been done is essentially "on the right track," and that valuable insights have been gained which will aid in further related investigation. The investigator plans to continue working in this area, hopefully with the increased involvement of others who have expressed interest in the project and are prepared to contribute from their specialized knowledge of this "domain."

-- Elizabeth Jane Simpson,
Principal Investigator

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The investigator wishes to express her appreciation to those who shared in any way in the project herein reported. She is especially grateful to Miss Carol Hodgson, Mrs. Nancy Carlson, and Mrs. Mildred Griggs, who served as research assistants on the project, for their creative approach to the task, their enthusiasm, hard work, and loyalty. A note of thanks is also extended to Miss Diane Wilson, who typed for the small "project staff" and assisted in various other ways.

The associate investigators, Professors Alfred Krebs and Jacob Stern, gave of their time, interest and effort and their many contributions are gratefully acknowledged.

A number of members of the College of Education, University of Illinois, were consulted from time to time; appreciation for their contributions is hereby expressed. In addition, the investigator wishes to thank the other consultants from within and without the University who gave assistance of various types. Special mention should be made of the helpful conferences held with Professor Ray Loree, College of Education, University of Alabama, and Professor Marvin I. Clein, Department of Physical Education for Men, University of Denver.

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THE CLASSIFICATION OF EDUCATIONAL OBJECTIVES, PSYCHOMOTOR DOMAIN

A Progress Report

CHAPTER I. INTRODUCTION

Educational objectives may be characterized as dealing with developments in the areas of the cognitive, affective, or psychomotor. A complete classification system for educational objectives, would, therefore, provide for classification of objectives in each of the three domains. The purpose of the project reported here was: to develop a classification system for educational objectives in the psychomotor domain, if possible in taxonomic form.

The Taxonomy of Educational Objectives, Cognitive Domain by Bloom and others was published in 1956. It provided for classification of educational goals which deal with the recall or recognition of knowledge and the development of intellectual abilities and skills [1]. Briefly, the purposes of the taxonomy as given by its originators are:

1. To help teachers, administrators, professional specialists, and research workers who deal with curricular and evaluation problems to discuss their problems with greater precision.

2. To facilitate the exchange of information about curricular developments and evaluation devices.

3. To suggest the kinds of objectives that can be included in a curriculum.

4. To help teachers and others to gain a perspective on the emphasis given to certain behaviors by a particular set of educational plans.

5. To help curriculum builders to specify objectives so that it becomes easier to plan learning experiences and prepare evaluation devices.

The second part of the taxonomy, on the affective domain, was presented at the Febcuary 1964 meeting of the American Educational Research Association. Objectives in this domain deal with interests, desires, appreciations, and attitudes. The taxonomy for this second domain was published during the fall of 1964.

Those who proposed taxonomies for the first two domains indicated that they had no special interest in the development of a classification system for educational objectives in the third domain. They stated that:

> Although we recognize the existence of this domain, we find so little done about it in secondary schools or colleges, that we do not believe the development of a classification of these objectives would be very useful at present. We would appreciate comments on this point from teachers and other educational workers who are especially interested in this domain of educational objectives [2].

Later statements made by those who gave leadership to development of the first two taxonomies of educational objectives gave no evidence of a change in interest or intent with respect to development of the third.

Need for Classification System for Educational Objectives, Psychomotor Domain

The investigator and her co-workers have made use of the two taxonomies of educational objectives already developed. They and others felt a serious lack in not having a classification system for educational objectives in the psychomotor domain, for use in the development of curriculum materials and as a basis for evaluation of educational outcomes.

The investigator believes that the psychomotor domain has relevance for education in general as well as for such areas of specialization as industrial education, agriculture, home economics, business education, music, art, and physical education. Educators in her own field of vocational and technical education have a keen interest in the development of a classification system for educational objectives in this domain because many

technical jobs require a high degree of ability and skill in the psychomotor domain as well as in the cognitive and affective areas.

A classification system for psychomotor objectives has all of the advantages of the classification systems for the other two domains. It can be of use in research on teaching for the development of motor abilities and skills. Teachers and curriculum makers can make use of it in developing materials for classroom use; and test makers can use it to communicate more easily with those they serve. Perhaps the greatest benefit will accrue from rounding out the three domains, and thus providing for better study of the total field of objectives and the planning of educational programs in response to objectives broadly conceived.

Development of a taxonomy of educational objectives, psychomotor domain, is basic to other research on the development of psychomotor abilities and skills needed in vocational technical education. Therefore, it can not only serve as a tool for curriculum builders but for researchers as well.

Difficulties Inherent in the Task

Preliminary investigations with respect to the development of a classification system for educational objectives in the psychomotor domain led to the conclusion that there is a hierarchy among the three domains. The cognitive domain, though certainly very complex, is, in a sense, somewhat "purer" than the other two domains. That is, cognition can take place with a minimum of motor activity. Also, feeling may not be greatly involved--although it would seem reasonable to assume some degree of affect. The affective domain necessarily involves considerable cognition as well as feeling. And, the psychomotor domain, as implied in the very name, involves cognition and motor activity, as well as affective components involved in

the willingness to act. The increasingly strong involvement of all three domains, from the cognitive to the affective to the psychomotor, results in a special problem of complexity in developing a classification system for this last domain.

Preliminary investigations also revealed another problem--that of rendering the system taxonomic. A classification system that is not taxonomic would have merit in the study of educational objectives. But, one that is taxonomic should prove more valuable in determining the relative difficulty of achieving the objectives and as an aid in determining sequence of learning experiences. The problem is one of arriving at a basis for determining the relative difficulty or amount of skill involved in carrying out a motor activity.

First Steps

Reference has been made to preliminary work on development of a classification system for the psychomotor domain. A brief review of this work may be appropriate.

Such work was undertaken during 1964-65 through a small grant from the Bureau of Educational Research, College of Education, University of Illinois. A partial survey of the literature on the development and classification of psychomotor abilities and skills was conducted. Specialists in vocational education, physical education, dentistry, psychology, and educational testing were among those consulted in regard to educational objectives in the realm of the psychomotor, relevant research data, and possible procedures in developing the classification system. Some progress was made toward collecting statements of educational objectives in the psychomotor domain. A limited analysis of the behavioral aspects of the objectives was done and a tentative and rudimentary schema for classification

developed. Following is the schema in the form achieved at this time:

Status of Schema, June, 1965

1. Perception
   - 1.10 Auditory
     - 1.11 Sensitivity to cues
       - 1.111 Volume
       - 1.112 Pitch
       - 1.113 Timbre
       - 1.114 Pattern of sounds
       - 1.115 Spatial relations (questionable)
   - 1.20 Visual
     - 1.21 Sensitivity to cues
       - 1.211 Color
       - 1.212 Spatial relations
       - 1.213 Shape (line, form, size)
       - 1.214 Motion
       - 1.215 Light
       - 1.216 Shade
   - 1.30 Tactile
     - 1.31 Sensitivity to cues
       - 1.311 Texture
       - 1.312 Temperature
       - 1.313 Shape
       - 1.314 Size
       - 1.315 Pressure
       - 1.316 Position
       - 1.317 State of motion
       - 1.318 Weight
   - 1.40 Taste
     - 1.41 Sensitivity to cues
       - 1.411 Saltiness
       - 1.412 Sourness
       - 1.413 Bitterness
       - 1.414 Sweetness
   - 1.50 Smell
     - 1.51 Sensitivity to cues
       - 1.511 Ethereal (fruity, lemon)
       - 1.512 Fragrant (violet)
       - 1.513 Burned (tar)
       - 1.514 Putrid (bad fish)
       - 1.515 Resinous (pine)
       - 1.516 Spicy (cloves)

2. Disposition to act and organization for action
   - 2.10 Response to stimulus
     - 2.11 Perceptual and mental set
       - 2.111 Identification--placing item perceptualized into one of a number of categories provided by our past experience

2.112 Setting into a context
2.113 Significance for ensuing action

2.12 Translation process (relating of perception to action)

3. Motor activity
3.10 Bodily set to perform task (positioning)
3.11 Posture
3.12 Balance
3.13 Aiming

3.20 Gross motor abilities
3.21 Movement involving trunk
3.22 Movement involving legs
3.23 Movement involving arms

or

3.21 Standing
3.22 Walking
3.23 Running and stopping
3.24 Jumping, leaping, hopping, etc.
3.25 Landing and falling
3.26 Sitting
3.27 Pushing and pulling
3.28 Holding, lifting, carrying
3.29a Throwing and catching
3.29b Striking

3.30 Fine motor abilities
3.31 Manual dexterity
3.311 Handling without gripping
3.312 Gripping with palm
3.32 Finger dexterity
3.321 Fingering without gripping
3.322 Gripping with fingers
3.323 Movement
3.33 Foot and toe dexterity
3.34 Facial muscular activity

A report on the progress of the project as of May, 1965, was given at the National Conference on Contemporary Issues in Home Economics Education held at the University of Illinois. The report, presented by Carol Hodgson, research assistant assigned to the project, appears in the bulletin, Contemporary Issues in Home Economics, A Conference Report, published by the National Education Association.

CHAPTER II. REVIEW OF LITERATURE

A number of references were located which threw some light on the problem of developing a classification system for educational objectives in the psychomotor domain.

The Taxonomy of Educational Objectives, Handbook I: Cognitive Domain [3], includes a discussion of the nature and development of the taxonomy and the problems of classifying educational objectives as well as a schema for classifying objectives in this domain. The guiding principles for the development of this taxonomy were helpful as guides in the present project. They were:

- "...the major distinctions between classes should reflect, in large part, the distinctions teachers make among student behaviors.
- "...the taxonomy should be logically developed and internally consistent.
- "...the taxonomy should be consistent with our present understanding of psychological phenomena.
- "...the classification should be a purely descriptive scheme in which every type of educational goal can be represented in a relatively neutral fashion" [4].

At the 1964 meeting of the American Education Research Association, Krathwohl, Bloom, and others presented the Taxonomy of Educational Objectives, Affective Domain [5]. The interrelationship between cognition and feeling shown in the classification system for this domain was of interest to the investigator since the psychomotor domain also involves the interrelationship of aspects of behavior in more than one domain.

Work on the classification system for educational objectives, psychomotor domain, was largely exploratory in nature. This and that approach were tried. The work did not proceed from a theoretical base because it was felt that this might impose undesirable limits on a project of this

nature. Also, there was precedent for the exploratory approach in the development of the taxonomies for the first two domains. Support for research not based on theory has been given by Skinner who indicated that the most rapid progress toward an understanding of learning may be made by research that is not designed to test theories [6]. Reasons which were given are: theories create a false sense of security and may limit the scope of research and most theories are discarded [7].

Metheny expressed the opinion that the term, psychomotor, is an inappropriate one for the third domain. She suggested that the proper mate for affective, which is derived from afferent, is effective, from efferent. She would subdivide the effective domain into two major categories, psycho-effective and somato-effective: in this way recognition would be given the influences of both mind and body [8].

Loree, in speaking at the National Conference on Contemporary Issues in Home Economics Education, expressed an interesting idea regarding the third domain. He stated that:

> The builders of the taxonomy originally thought of three domains: cognitive, affective, and psychomotor. The psychomotor domain, I believe, can better be thought of as a part of a larger domain. I have borrowed the term 'action-pattern domain' for objectives in which some motor response constitutes the essence of the objectives. Psychomotor skills would constitute one category within this domain. Competencies such as speech making, organizing a committee, and the like belong in the action-pattern domain. Personal-social adjustment objectives that describe the mature individual or law abiding individual and do not make any inferences concerning his motivations, his feelings about being mature, acting mature, or following the law, or his satisfactions in doing so, or the personalized meaning of his behaving as he does, belong in the action-pattern domain [9].

The investigator found Loree's idea an appealing one and pursued it at some length before concluding that the "action-pattern domain" was an all-encompassing one that might very well be a fourth domain extending beyond and including the three already identified in the original work on

the classification systems. Even though the psychomotor domain involves behaviors of all three domains to a considerable extent, the primary concern is with abilities and skills which have motor activity as a focus; this is what the investigator regards as the psychomotor domain.

The foregoing references were relevant to the research in its general nature. Early explorations made as a part of the project were motivated by the ideas expressed by both Metheny and Loree.

It was readily apparent that a first step in motor activity is perception. Hence, a survey of literature dealing with perception was made.

Berelson and Steiner defined perception as "the more complex process by which people select, organize and interpret sensory stimulation into a meaningful and coherent picture (of the world)" [10].

Perception, as defined by Hilgard, is the process of becoming aware of objects, qualities or relations by way of the sense organs. Sensory content is always present in perception; therefore, what is perceived is influenced by set and prior experience so that perception is more than passive registration of stimuli impinging on the sense organs [11].

Cratty defined perception as the process of attaching meaning to "objects, events, or situations occurring within the spatial and temporal proximity of the individual" [12]. This process, according to Woodworth [13], Cratty [14], Berelson and Steiner [15], involves more than a response to sensory stimulation; it includes organizing, feeling change and selecting. Bartley stated in Principles of Perception that there is no systematic and comprehensive statement of perception to be found [16].

Gagne and Foster indicated that the learning of motor tasks is largely a matter of learning perceptual relationships. The perceptual aspect of the task is the thing which has the greatest effect on the learning of

motor skills [17]. Agreement with this view was expressed by Baldwin, who conferred with the investigator regarding the attempt to develop a classification system for educational objectives in the psychomotor domain. He believes that much more importance should be attached to "input" than to "output" in the teaching and learning of a motor skill. By input he was referring to the cognitive aspects of the task-perceiving, relating perceptions, and developing the mental set preparatory to action; by output, he meant the actual doing of the task [18].

Berelson and Steiner identified three factors which influence the selection of stimuli which are involved in perception. The three factors are: (1) nature of the stimuli, (2) previous learning or experiences as it affects the observer's expectations, and (3) motives in play at the time [19].

Set is the preparatory adjustment for a particular kind of action or experience. This is the task preparation phase. Preparatory set was defined by Woodworth as being "a state of readiness to receive a stimulus or readiness to make a response which cannot be made until a preliminary movement has been made" [20]. Discrimination in the pre-set stage facilitates responses for which one is set and inhibits other activities.

Educational objectives in the psychomotor domain are usually stated in terms of abilities and skills. Hence, a definition of these terms became important in the study. Parker and Fleishman made a distinction between the two that was of interest:

> Ability refers to a more general, stable trait of the individual which may facilitate performance in a variety of tasks. Thus, the term of spatial-visualization may be important in such diverse activities as navigation, dentistry, and engineering. The term skill is more specific: it is task oriented. Flying an air plane is a skill, while manual dexterity and spatial-visualization are more important general abilities. Abilities are often products of earlier learning [21].

A number of definitions of skills were located Munn defined skill as proficiency in the performance of a task. He identified two kinds of tasks, motor and language, but added that motor skills are to some extent verbal, and verbal skills are partly motor [22].

Motor skill was defined by Gagne and Fleishman as a sequence of habitual responses. The order of the responses is partially or wholly determined by sensory feedback from preceding responses [23].

The first prerequisite of a skill, according to Laban and Lawrence, is the economy of effort. Skill is defined as the final stage of perfection [24].

Cronbach stated that a skill is easy to describe but hard to define. He defined a skilled movement as "a very complex process involving differentiation of cues and continual correction of errors" [25].

Mohr defined skill learning as "progress toward better performance in motor activity as a result of instruction and/or practice. Motor activity includes all specific and generalized movements involving motor coordination, and better performance implies progress resulting in improved motor coordination" [26].

According to Seashore, skill is a degree of efficiency in performing an act and all skills involve the action of the entire body rather than only large muscles or small muscles. He also indicates that motor skills involve three variables which are: speed, strength, and steadiness or precision [27]. Stone suggests that major factors in motor skill are muscular control, which might correspond to Seashore's steadiness or precision, and accuracy and economy of force [28].

Hall recognized two major types of motor skills, fine and gross [29]. Fine and gross motor acts were defined by Espenschade as follows: "Fine

motor acts are performed by small muscles, especially of the fingers, hand and forearm, and frequently involve eye-hand coordination. Gross motor acts involve the large muscle groups of the body, especially of the shoulders, trunk, and legs" [30].

Bennett classified the basic elements or components of general motor ability as: (1) agility, (2) coordination, (3) strength, (4) flexibility, (5) balance, and (6) endurance [31].

A number of references dealing with movement types were located. Smith and Smith indicated that there are three types of movement: (1) postural, which are large movements regulating body position, (2) transport, or travel movements of parts of the body, and (3) manipulative, movements which involve the smaller muscles of the terminal members of the body or the receptor system of the head [32]. Stone has classified movement into five categories which are: (1) maximum force impulse, (2) slow tension movement, (3) rapid tension, (4) ballistic, and (5) oscillating movements [33].

In Motion and Time Study, Barnes reported five different movements [34]. They were, from the less to the increasingly complex, motions involving:

1. fingers;
2. fingers and wrist;
3. fingers, wrist, and forearm;
4. fingers, wrist, forearm, and upper arm; and
5. fingers, wrist, forearm and upper arm, shoulder, and perhaps the whole body.

Munn discussed the concept of "habit hierarchy," which he defined as a complex skill involving integration of simpler skills He gave, as an example, typing: this involves letter habit, word habit, and phrase habit before it becomes an automatic, complex skill [35].

Two types of performance were identified by Seashore There are: single action, which is one coordinated response which follows a given

stimulus pattern, and serial action or a continuous pursuit type of coordination, i.e., typing, cutting out a garment, painting, drilling, etc [36].

Stetson stated that there are two major types of movement, each having two subtypes: tense and ballistic. Of the tense type there are either fixations with no muscle displacement or moving fixations. Ballistic movements are either completely free movements with only contraction of one muscle pair or stiff movements with rapid muscle contraction of one muscle superimposed upon tension of both members of the antagonistic pair [37].

Human motion has been analyzed by M. Gladys Scott. She divided it into four types. These types are limited only to bodily movement and do not take into account the cognitive aspects of motor activity. Her types are (1) precision skills, (2) pushing and pulling, (3) throwing, and (4) striking [38].

Hartson has set up a classification system of work types to facilitate analysis of the movement process. He has organized it, first of all, from the standpoint of basic posture; then, from ballistic movements featuring locomotion, to upper arm movements, lower arm movements, vocal movements, and eye movements. He has also included examples of activities related to each division and subdivision. Although highly structured, his organization appears to be incomplete for the purpose of the present project [39].

Cratty defined motor performance as "a relatively short-term aspect of movement behavior marked by movement oriented toward the execution of an identifiable task." He stated that "motor skill may be termed reasonably complex motor performance" [40]. He added:

> The term skill denotes that some learning has taken place and that a smoothing or an integration of behavior has resulted. Extraneous movements have been omitted, and the performance is executed with increasing speed and accuracy, a decrease in errors, or perhaps the ability to apply greater force" [41].

Cratty indicated that there is no clear-cut line between fine and gross motor skills. He stated that:

> ...Rather, it is believed that skills may be placed upon a continuum, from those which may be considered 'gross' to those which may be termed 'fine.' To those movement performances near the 'fine' end of the continuum the term manual, or manipulative skill, has usually been applied.
>
> Classification of motor tasks into various portions of this continuum may be made with reference to the size of muscle involved, the amount of force applied, or to the magnitude of space in which the movement is carried out [42].

Cratty stated that "other subjective methods of classifying motor performance are based upon whether the task is a discrete one, one involving a single isolated kind of response, or whether it is a serial-act" [43].

Still another way of classifying has been suggested by Poulton who indicated that some motor tasks might be termed closed skills, those movements requiring little or no correction from the environment or visual regard on the part of the performer, and open skills, those needing constant checking either because of unpredictable environmental influences or because of the degree of exactitude required. He added that some tasks might be mixed in nature, combining elements of both closed and open skills [44].

According to Crow and Crow, "the aim of motor learning is to develop proficiency in whatever skill is being learned. The simpler skills are mastered by utilizing movements already learned and combining them into a workable pattern. After the skill has been perfected to a point that the individual shows proficiency in it, he is considered to have formed the skill" [45].

Fleishman studied psychomotor abilities with the purpose of finding a limited number of ability categories which would be helpful in describing

performance in a wide range of psychomotor tasks. He isolated ten independent factors in psychomotor skill. These were not set into any kind of organizational pattern. The ten factors are: wrist finger speed, finger dexterity, rate of arm movement, manual dexterity, arm-hand steadiness, reaction time, aiming, psychomotor coordination, postural discrimination, and spatial relations [46]. The factors isolated by Fleishman were taken into account in the work that has been done with respect to the classification system for the psychomotor domain.

In discussing what happens when one carries through a motor act, Howell indicated that a complex act usually proceeds so rapidly that it is difficult to determine exactly what happened [47]. However, Scott analyzed a skill into three stages: (1) preparatory movement, (2) action, and (3) follow-through [48].

According to Stone there are five steps in learning a new motor skill. These steps are: understanding, observation, concentration on the skill to be performed, practice and reflex. "The reflex action occurs when full attention is no longer given to the act, slight decreases in importance, feeling is present, and muscle sense is present" [49].

Many references were scrutinized for the help that they might provide in developing a classification system for educational objectives in the psychomotor domain. Most contributed something to the development of a background of understanding for work on the project. Those that have been reported in this chapter appeared to offer the most in terms of material directly related to the project.

CHAPTER III. PROCEDURES

As has been stated, the objective of this project was: To develop a classification system for educational objectives, psychomotor domain, and if possible, in taxonomic form. The approach taken was an exploratory one. General procedures to guide the investigators were outlined, but these were deliberately left flexible, accommodative, and "open."

The disadvantage of such an approach is the possibility of some loss of time and energy in pursuing the objective; that is, this approach may be somewhat lacking in efficiency. On the other hand, it avoids the narrow restrictiveness of a more cut-and-dried approach. It opens the way for the possibilities of greater creativeness.

Work undertaken during 1964-65 toward achievement of the objective has already been outlined in Chapter I and will not be repeated here. Suffice to say, the work did give the investigator some confidence that the general procedural plan being followed might be a fruitful one.

General procedures included the following:

1. A comprehensive review of related literature, especially of any that described ways of classifying psychomotor activities, and, hence, suggested possibilities for classifying the educational objectives of this domain.

2. Collecting and analyzing the behavioral objectives of this domain as one way of gaining insight regarding a possible classification system.

3. Laboratory analyses of certain tasks to discover by observation and introspection the nature of the psychomotor activity involved. These analyses were carried out by the research assistants on the project who had read widely in the area before attempting the analyses.

4. Conferences with scholars who have specialized knowledge of the nature of psychomotor activity, development of classification systems for educational objectives, and of the areas of study where educational objectives in the psychomotor domain are of paramount concern.

From the beginning, it was readily apparent that, if the classification system were to be taxonomic in form, an "organizing principle" would have to be found. This question was one that the investigators kept in mind as work progressed.

Ascertaining what objectives "fit" in this domain was an early concern. The definition given in the Taxonomy of Educational Objectives, Affective Domain [50] served as a guide: Psychomotor objectives are those which "emphasize some muscular or motor skill, some manipulation of material and objects, or some act which requires a neuromuscular coordination."

Examples which were checked and approved by specialists in the subject fields involved as belonging in the psychomotor domain were presented by Carol Hodgson as part of her progress report at the National Conference on Contemporary Issues in Home Economics Education. These were:

Industrial Arts

1. To develop skill in precision surface grinding operations
2. To develop skill in setting-up and operating a production drill press
3. To develop skill in setting-up and operating a production band saw

Agriculture

4. To develop skill in using an instrument similar to a syringe in penetrating a peach to extract a measured amount of juice and pulp to determine spray residue
5. To develop ability to pollinate an oat flower which involves using tweezers to open palea to place pollen on the stamen
6. To develop manipulative skill in debeaking a chick
7. To develop ability to place flowers on desired foundations based on a preconceived idea with regard to a particular arrangement

Home Economics

8. To develop skill in draping material to fit a certain body proportion with a particular pre-conceived design

9. To develop skill in designing a flat pattern which can be used to make a garment

10. To develop ability to whip egg whites to their maximum volume

Music

11. To develop correct arm, hand, and finger positions in holding and playing a violin in response to aural cues

12. To develop ability of a student to play his part in a synchronized and balanced way with a group of students in the production of a piece of music

13. To develop skill in directing a musical group so that each movement has the same interpretation to each person in the group

14. To develop ability to produce the required amount of lip and breath control to achieve the desired duration, volume and character of a note on a French horn

Physical Education

15. To develop ability to maneuver and control one's body in propelling the body upward through the air as in high jumping

16. To develop ability to maintain proper stance and execute follow-through of movement after hitting a golf ball

17. To develop ability to draw a bow and hold that position while aiming arrow

18. To develop ability to throw a ball a desired distance to a desired place

Art

19. To develop ability to sketch a figure and costume it with the desired clothing design

20. To develop ability in manipulating a shuttle in weaving fabric on a loom

It was not always an easy task to ascertain whether a given objective was primarily of one type or another. One problem was related to <u>type</u> of <u>performance</u> called for in the objective. The concern of this project is

performance of a particular sort, that involving motor activity. But, performance may be almost wholly of a cognitive type and, although at this point of time with reference to the project, it seems a bit strange, confusion sometimes resulted from uncertainty regarding the primary nature of the activity involved in an objective.

Another problem, one that is frequently encountered in analyzing educational objectives in all three domains, had to do with the lack of specificity of the objectives. That is, many that certainly involved a great deal of motor activity, almost equally also involved the other domains. These were broad objectives, such as: Ability to give a successful party. Ability to conduct a meeting. Ability to conduct a play period for small children. The investigators finally concluded that these were in the "action-pattern" domain, hence beyond and encompassing the other three domains.

Certain definitions were arrived at as ones that would be useful in communicating regarding the psychomotor domain. These were as follows:

psychomotor objectives - those which emphasize some muscular or motor skill, some manipulation of material and objects, or some act which requires a neuromuscular coordination. These objectives are stated in terms of abilities and skills.

perception - the process of becoming aware of objects, qualities, or relations by way of sense organs.

sensory stimulation - impingement of a stimulus (i) upon one or more of the sense organs.

stimulus - the source of energy which affects a sense organ; what the behavior is responding to in a situation.

cues - a stimulus which serves as a sign or signal of something else, the connection having been previously learned.

visual - concerned with the mental pictures or images obtained through the eyes.

visual cues - color, spatial relations, shape (line, form, size), motion, light and shade.

auditory - pertaining to hearing or the sense or organs of hearing.

auditory cues - volume, pitch, timbre, distance, pattern of sounds.

tactile - pertaining to the sense of touch.

tactile cues - texture, temperature, shape, size, pressure, position, state of motion, weight.

taste - ascertaining the relish or flavor of by taking some into the mouth.

taste cues - saltiness, sourness, bitterness, sweetness.

smell - to perceive by excitation of the olfactory nerves.

smell cues (odors) - ethereal, such as fruity, lemon; fragrance, as violet; burned, as tar; putrid, as bad fish; resinous, as pine; spicy, as cloves.

kinesthetic - the muscle sense; pertaining to sensitivity from activation of receptors in muscles, tendons, and joints.

cue selection - deciding what cues one must respond to in order to satisfy the particular requirements of task performance.

reflex action - an act, as a movement, performed involuntarily in consequence of a nervous impulse transmitted inward from a receptor, or sense organ, to a nerve center and outward to an effector, as a muscle or gland.

set - a preparatory adjustment or readiness for a particular kind of action or experience.

mental set - readiness, in the mental sense, to perform a certain motor act.

physical set - readiness in the sense of having made the anatomical and postural adjustments necessary for the motor act to take place.

emotional set - readiness in terms of attitudes favorable to the motor act's taking place.

translation process - process of relating perception to action.

response - overt behavioral act of an individual.

mechanism - a habitual way of responding.

readiness to respond - set to produce an overt behavioral act.

gross motor acts - those involving the large muscle groups of the body, especially of the shoulders, trunk, and legs.

fine motor acts - those that are performed by small muscles, especially of the fingers, hand and forearm, frequently involving eye-hand coordination.

Assistants on the project attempted to determine exactly what happens in what sequence when one is working toward the achievement of an objective in this domain. Two examples of the results of these efforts follow:

OBJECTIVE	SEQUENCE OF ACTION IN CARRYING OUT TASK
A. Ability to stack a tray.	1. Perception Visual, tactile, and kinesthetic 2. Set Mental set-discrimination Physical set - receptor set, and postural set 3. Response Readiness Selection of response Imitation Gross muscular activity 4. Mechanism - Response is learned 5. Complex overt response Resolution of uncertainty Automatic performance
B. Ability to carry a large tray	1. Perception 1.12 Visual 2. Set 2.10 Mental set 2.11 Discrimination 2.20 Physical set 2.21 Receptor set 2.22 Postural set 3. Response 3.10 Readiness to respond 3.20 Selection of response 3.21 Imitation 3.22 Trial and error 4. Mechanism - Learned response 5. Complex 5.10 Resolution of uncertainty 5.20 Automatic performance

At various times, the guidance and reaction of consultants were sought. The following persons were consulted during the course of the project as herein reported:

Jack A. Adams, Professor of Psychology, University of Illinois

Thomas S. Baldwin, Research Associate Professor, University of North Carolina

Glenn M. Blair, Professor of Educational Psychology, University of Illinois

Thomas Cureton, Professor of Physical Education for Men, University of Illinois

Marvin Clein, Professor of Physical Education for Men, University of Denver

Charles Cyrus, Training Specialist, University of Texas, Austin

Helga Deutsch, Instructor in Physical Education for Women, University of Illinois

Norman Gronlund, Professor of Educational Psychology, University of Illinois

J. Thomas Hastings, Professor of Educational Psychology, University of Illinois

Laura Huelster, Professor of Physical Education for Women, University of Illinois

Charles Hulin, Professor of Psychology, University of Illinois

R. Stewart Jones, Professor of Educational Psychology, University of Illinois

Devore E. Killip, Assistant Professor, Postgraduate and Teacher Education, University of Illinois Medical Center, College of Dentistry

C. G. Knapp, Professor of Secondary and Continuing Education (Physical Education), University of Illinois

Alfred Krebs, Professor of Vocational and Technical Education (Agricultural Education), University of Illinois

David Krathwohl, Dean, College of Education, University of Syracuse

Ray M. Loree, Professor of Educational Psychology, University of Alabama

Elizabeth Melson, Associate Professor of Business Education, University of Illinois

Charles Leonhard, Professor of Music, University of Illinois

Harold Schultz, Professor of Arts, Departments of Arts and Elementary Education, University of Illinois

Celia Stendler, Professor of Elementary Education, University of Illinois

Jacob Stern, Professor of Vocational and Technical Education (Industrial Education), University of Illinois

William Stone, Department of Physical Education for Men, University of Denver

Mariana Trekell, Assistant Professor of Physical Education for Women, University of Illinois

C. J. Van Horn, Assistant Professor, Educational Psychology, University of Illinois

W. Wichlarajote, Graduate Student, Educational Psychology, University of Illinois

Helen Zwolanek, Assistant Professor of Textiles and Clothing, University of Illinois

Most of those consulted were extremely helpful in terms of suggesting related readings. One or two suggested research activities of a related nature which might provide "seed" for future explorations.

Much inspiration and several new insights were gained from Professor Ray Loree's speech on the "Relationships Among Three Domains of Educational Objectives" presented at the National Conference on Contemporary Issues in Home Economics Education at the University of Illinois, May, 1965. In addition, Professor Loree conferred with the investigator and the assistants on the project both in person and by mail. His ideas regarding the action-pattern domain were particularly provocative.

Helga Deutsch of the University of Illinois Department of Physical Education for Women was generous with her time in conferring with the assistants regarding the sequence involved in performing a motor act.

Because of his intense interest in the subject and because he had already given some thought to the development of a classification system

for educational objectives in the psychomotor domain, Professor Marvin Clein of the University of Denver was invited to spend a day with the investigator and the two assistants reacting to the schema in one of its several forms. He was accompanied by Mr. William Stone, also of the staff, Physical Education for Men, University of Denver. Mr. Stone had also done considerable thinking about this domain and its relevance to physical education. Interestingly, independent work by these two had led them to conclusions similar to those reached by the investigator with respect to the schema in its broad, general outlines. This conference was particularly helpful in providing some security and sense of direction for further work.

A conference with Professor Thomas Baldwin came about informally but proved very interesting and helpful. Professor Baldwin was in agreement regarding the general nature of the schema as it was developing. His discussion of the importance of "input" in relation to "output" in performing a motor act has already been noted.

Mrs. Carlson and Mrs. Griggs attended the 1966 meeting of the American Educational Research Association in order to hear reports of research related to the taxonomy of educational objectives, cognitive domain. The studies reported at this meeting were reviewed for any relevance they might have for the present project.

As the described procedures were being carried out, a number of attempts at the development of a useable classification system were being made. The following chapter reports the schema in its present form.

CHAPTER IV. CLASSIFICATION OF EDUCATIONAL OBJECTIVES, PSYCHOMOTOR DOMAIN: A TENTATIVE SYSTEM

The following schema for classification of educational objectives in the psychomotor domain is presented with the full knowledge that it is still in a very tentative form. Even if the investigator felt quite confident about the system she would, at best, have to admit that it could not be sufficiently tried, in any of its versions, during the one-year funding period.

The major organizational principle operative is that of complexity, with attention to the sequence involved in the performance of a motor act.

1.0 Perception - This is an essential first step in performing a motor act. It is the process of becoming aware of objects, qualities, or relations by way of the sense organs. It is the central portion of the situation - interpretation - action chain leading to purposeful motor activity.

The category of perception has been divided into three subcategories indicating three different levels with respect to the perception process. It seems to the investigator that this level is a parallel of the first category, receiving or attending, in the affective domain.

1.1 Sensory stimulation - Impingement of a stimulus (i) upon one or more of the sense organs.

1.11 Auditory - Hearing or the sense or organs of hearing

1.12 Visual - Concerned with the mental pictures or images obtained through the eyes

1.13 Tactile - Pertaining to the sense of touch

1.14 Taste - Ascertain the relish or flavor of by taking a portion into the mouth

1.15 Smell - To perceive by excitation of the olfactory nerves

1.6 Kinesthetic - The muscle sense; pertaining to sensitivity from activation of receptors in muscles, tendons, and joints

The preceding categories are not presented in any special order of importance, although, in Western cultures, the visual cues are said to have dominance, whereas in some cultures, the auditory and tactile cues may pre-empt the high position we give the visual. Probably no sensible ordering of these is possible. It should also be pointed out that "the cues that guide action may change for a particular motor activity as learning progresses (e.g., kinesthetic cues replacing visual cues)" [51].

1.1 Sensory stimulation - Illustrative educational objectives.

Sensitivity to auditory cues in playing a musical instrument as a member of a group.

Awareness of difference in "hand" of various fabrics.

Sensitivity to flavors in seasoning food.

1.2 Cue selection - Deciding to what cues one must respond in order to satisfy the particular requirements of task performance.

This involves identification of the cue or cues and associating them with the task to be performed. It may involve grouping of cues in terms of past experience and knowledge. Cues relevant to the situation are selected as a guide to action; irrelevant cues are ignored or discarded.

1.2 Cue selection - Illustrative educational objectives.

Recognition of operating difficulties with machinery through the sound of the machine in operation.

Sensing where the needle should be set in beginning machine stitching.

Recognizing factors to take into account in batting in a softball game.

1.3 Translation - Relating of perception to action in performing a motor act. This is the mental process of determining the meaning of the cues received for action. It involves symbolic translation, that is, having an image or being reminded of something, "having an idea," as a result of cues received. It may involve insight which is essential in solving a problem through perceiving the relationships essential to solution. Sensory translation is an aspect of this level. It involves "feedback," that is, knowledge of the effects of the process; translation is a continuous part of the motor act being performed.

1.3 Translation - Illustrative educational objectives.

Ability to relate music to dance form.

Ability to follow a recipe in preparing food.

Knowledge of the "feel" of operating a sewing machine successfully and use of this knowledge as a guide in stitching.

2.0 Set - Set is a preparatory adjustment or readiness for a particular kind of action or experience.

Three aspects of set have been identified: mental, physical, and emotional.

2.1 Mental set - Readiness, in the mental sense, to perform a certain motor act. This involves, as prerequisite, the level of perception and its subcategories which have already been identified. Discrimination, that is, using judgment in making distinctions is an aspect.

2.1 Mental set - Illustrative educational objectives.

Knowledge of steps in setting the table.

Knowledge of tools appropriate to performance of various sewing operations.

2.2 Physical set - Readiness in the sense of having made the anatomical adjustments necessary for a motor act to be performed. Readiness, in the physical sense, involves receptor set, that is, sensory attending, or focusing the attention of the needed sensory organs and postural set, or positioning of the body.

2.2 Physical set - Illustrative educational objectives.

Achievement of bodily stance preparatory to bowling.

Positioning of hands preparatory to typing.

2.3 Emotional set - Readiness in terms of attitudes favorable to the motor act's taking place. Willingness to respond is implied.

2.3 Emotional set - Illustrative educational objectives.

Disposition to perform sewing machine operation to best of ability.

Desire to operate a production drill press with skill.

3.0 Guided response - This is an early step in the development of skill. Emphasis here is upon the abilities which are components of the more complex skill. Guided response is the overt behavioral act of an individual under the guidance of the instructor. Prerequisite to performance of the act are readiness to respond, in terms of set to produce the overt behavioral act and selection of the appropriate response. Selection of response may be defined as deciding what response must be made in order to satisfy the particular requirements of task performance. There appear to be two major subcategories, imitation and trial and error.

3.1 Imitation - Imitation is the execution of an act as a direct response to the perception of another person performing the act.

3.1. Imitation - Illustrative educational objectives.

Imitation of the process of stay-stitching the curved neck edge of a bodice.

Performing a dance step as demonstrated.

Debeaking a chick in the manner demonstrated.

3.2 Trial and error - Trying various responses, usually with some rationale for each response, until an appropriate response is

achieved. The appropriate response is one which meets the requirements of task performance, that is, "gets the job done" or does it more efficiently. This level may be defined as multiple-response learning in which the proper response is selected out of varied behavior, possibly through the influence of reward and punishment.

3.2 Trial and error - Illustrative educational objectives.

Discovering the most efficient method of ironing a blouse through trial of various procedures.

Ascertaining the sequence for cleaning a room through trial of several patterns.

4.0 Mechanism - Learned response has become habitual. At this level, the learner has achieved a certain confidence and degree of skill in the performance of the act. The act is a part of his repertoire of possible responses to stimuli and the demands of situations where the response is an appropriate one. The response may be more complex than at the preceding level; it may involve some patterning of response in carrying out the task. That is, abilities are combined in action of a skill nature.

4.0 Mechanism - Illustrative educational objectives.

Ability to perform a hand-hemming operation.

Ability to mix ingredients for a butter cake.

Ability to pollinate an oat flower.

5.0 Complex overt response - At this level, the individual can perform a motor act that is considered complex because of the movement pattern required. At this level, a high degree of skill has been attained. The act can be carried out smoothly and efficiently, that is, with minimum expenditure of time and energy. There are two subcategories: resolution of uncertainty and automatic performance.

5.1 Resolution of uncertainty - The act is performed without hesitation of the individual to get a mental picture of task sequence. That is, he

knows the sequence required and so proceeds with confidence. The act is here defined as complex in nature.

5.1 Resolution of uncertainty - Illustrative educational objectives.

Skill in operating a milling machine.

Skill in setting up and operating a production band saw.

Skill in laying a pattern on fabric and cutting out a garmet.

5.2 Automatic performance - At this level, the individual can perform a finely coordinated motor skill with a great deal of ease and muscle control.

5.2 Automatic performance - Illustrative educational objectives.

Skill in performing basic steps of national folk dances.

Skill in tailoring a suit.

Skill in performing on the violin.

The investigator believes that the schema in its present form will be at least somewhat useful. Whether there is sufficient distinction between one category and another is still a question. Perhaps additional subcategories to improve the discrimination quality are needed for some of the major sections.

Another question that needs further investigation is: Is there perhaps a sixth major category which might be designated as adapting and originating? Possibly such a level is needed. At this level, the individual might

be so skilled that he can adapt the action in terms of the specific requirements of the individual performer and the situation. He might originate new patterns of action in solving a specific problem. Or, do these activities take place at all levels? Must the individual have attained a high degree of skill in order to adapt and originate?

The investigator found, not unexpectedly, that her work in this area has resulted in looking at educational objectives in the psychomotor domain in a new light. She has become aware that many objectives that are assumed might be stated in order to provide for greater clarity and to insure their consideration in the selection of learning experiences and content.

One next major step in that of providing for trial of the schema in many situations and revising it in light of the trials. Another important step that should be taken is that of looking critically at the relationships among the three domains. It is readily apparent that they are closely related and that a single educational objective might have a particular significance in one domain and another in another domain. For example, at the mental set level in performing a motor act, knowledge is required; hence, an objective that "fits" this level would also fit into the cognitive domain and could be classified here.

Much work is needed in studying the psychomotor domain and its relationships to the other two. What has been presented here is only a beginning.

Serious consideration needs to be given the "action-pattern" domain suggested by Loree [52]. The roles of subobjectives and the inter-play of "domains" in such broad objectives as the following is a matter requiring investigation: (1) To develop the ability to manage a farm. (2) To express ideas in a clear manner before a group. (3) To manage a home.

The magnitude of the tasks ahead is readily apparent. Direction is somewhat obscure. But, that is part of the fascination of working on a task that is essentially a creative one.

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